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Retrieving reflection arrivals from passive seismic data using Radon correlation

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Since explosive and impulsive seismic sources such as dynamite, air guns, gas guns, or even vibroseis can have a big impact on the environment, some companies have decided to record ambient seismic noise and use it to estimate the physical properties of the subsurface. Big challenges arise when the aim is extracting body-waves from recorded passive signals, especially in the presence of strong surface waves. In passive seismic signals, such body-waves are usually weak in comparison to surface waves which are much more prominent. To understand the characteristics of passive signals and the effect of natural source locations, three simple synthetic models were created. To extract body-waves from simulated passive signals we propose and test a Radon-correlation method. This is a time-spatial correlation of amplitudes with a train of time-shifted Dirac delta functions through different hyperbolic paths. It is tested on a two-layer horizontal model, three-layer model which includes a dipping layer (with and without lateral heterogeneity) and also on synthetic Marmousi model data sets. Synthetic tests show that the introduced method is able to reconstruct reflection events at the correct time-offset positions which are hidden in results obtained by the general cross-correlation method. Also, a depth migrated section shows a good match between imaged-horizons and the true model. It is possible to generate off-end virtual gathers by applying the method to a linear array of receivers and to construct a velocity model by semblance velocity analysis of individually extracted gathers.